

Appl. No. 10/720,311
Examiner: CHEN, KIN-CHAN, Art Unit 1765
In response to the Office Action dated January 5, 2006

Date: April 5, 2006
Attorney Docket No. 10113261

REMARKS

Responsive to the Office Action mailed on January 5, 2006 in the above-referenced application, Applicant respectfully requests amendment of the above-identified application in the manner identified above and that the patent be granted in view of the arguments presented. No new matter has been added by this amendment.

Present Status of Application

Claims 1-29 are pending in the application. Claims 10-15 are rejected under 35 U.S.C. 103(a) as being unpatentable over Tews (US 6,534,376) in view of Lim et al (US 6,828,185) as evidenced by Hsu et al (US 6,143,645). Claims 1-9 and 16-29 are allowed.

In this paper, claim 10 is amended to recite the step of plasma nitriding the sidewall of the trench of the substrate to form a sidewall nitride layer on the pad stack layer and the upper portion of the trench sidewall not covered by the photoresist layer, and that the photoresist layer is removed after forming the sidewall nitride layer. Support for the amendment can be found at least in Figs. 2C-2D and 3D-3E of the application.

Reconsideration of this application is respectfully requested in light of the amendments and the remarks contained below.

Allowable Subject Matter

Applicant thanks the Examiner for the allowance of claims 1-9 and 16-29.

Rejections Under 35 U.S.C. 103(a)

Claims 10-15 are rejected under 35 U.S.C. 103(a) as being unpatentable over Tews in view of Lim et al as evidenced by Hsu et al. To the extent that the grounds of the rejections may be applied to the claims now pending in this application, they are respectfully traversed.

MPEP 2142 reads in part:

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To establish a *prima facie* case of obviousness, three basic criteria must be met. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. Second, there must be a reasonable expectation of success. Finally, the prior art reference (or references when combined) must teach or suggest all the claim limitations. The teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art, and not based on applicant's disclosure. *In re Vaeck*, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991).

In connection with the third criteria, MPEP 2143.03 goes on the state:

To establish *prima facie* obviousness of a claimed invention, all the claim limitations must be taught or suggested by the prior art. *In re Royka*, 490 F.2d 981, 180 USPQ 580 (CCPA 1974). "All words in a claim must be considered in judging the patentability of that claim against the prior art." *In re Wilson*, 424 F.2d 1382, 1385, 165 USPQ 494, 496 (CCPA 1970).

In the rejection of claim 10, the Examiner relies on Fig. 5 of Tews to teach the step of filling a photoresist layer into the lower portion of the trench, Fig. 7 of Tews and Lim et al to teach plasma nitriding the substrate to form a sidewall nitride layer on the pad stack and the trench sidewall, Fig. 6 of Tews to teach the step of removing the photoresist layer, and Fig. 11 to teach the step of etching the lower portion of the trench to form a bottle-shaped trench. See pages 4-5 of the office action.

As amended, claim 10 recites a method for forming a bottle-shaped trench comprising the steps of providing a semiconductor substrate with a trench having a pad stack layer thereon; filling a photoresist layer into the lower portion of the trench; plasma nitriding a sidewall of the trench of the substrate to form a sidewall nitride layer on the pad stack layer and the upper portion of the trench sidewall not covered by the photoresist layer, wherein the plasma nitriding step has a process temperature of about 25~100°C; after forming the sidewall nitride layer, removing the photoresist layer; and etching the lower portion of the trench to form a bottle-shaped trench.

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Thus, in the method recited in claim 10, the sidewall nitride layer is formed on the pad stack layer and the upper portion of the trench sidewall not covered by the photoresist layer, and the photoresist layer is removed after forming the sidewall nitride layer. In contrast, Tews teaches that the resist 116 is removed prior to the nitridation process. See Figs. 6 and 7. The differences between the invention recited in claim 10 and the Tews' disclosure is also described in col. 5, lines 20-46 of the reference, which reads:

The resist 116 remaining within the trenches 113 is removed, e.g., stripped, using a CDE selective to semiconductor layer material 122 and first oxide layer 124, for example.

An optional second oxide layer 126 (shown in phantom in FIG. 6) may be deposited or formed over the exposed portions of semiconductor layer 122 prior to the removal of the resist 116. The optional second oxide layer 126 can ease the resist removal from the trench bottom. Second oxide layer 126 is preferably thinner than first oxide layer 124. For example, second oxide layer 126 may be about 5 Å to 20 Å thick. Second oxide layer 126 may comprise a thin plasma oxide, or may alternatively comprise other oxides such as an ozone oxide, as examples. Second oxide layer 126 is preferably removed after the resist 116 is removed from the trenches 113. Second oxide layer 126 may be removed in a cleaning step, for example.

The wafer 100 is exposed to a nitridation process, as shown in FIG. 7, to form a thermal nitride layer 128 over exposed portions of the semiconductor layer 122. Preferably the nitridation process comprises exposing the wafer 100 to a nitrogen-containing chemical, such as NH_3 . Because there is a time delay between nitridation of the semiconductor layer 122 and the nitridation of the first oxide layer 124, the nitride layer 128 comprises a very thin layer of nitride, e.g. about 15 Å of silicon nitride. The nitride layer 128 is grown on over the semiconductor layer 122 only, and in particular, nitride is not grown over first oxide layer 124, in accordance with an embodiment of the invention

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[Emphasis added]

The Tews method is more complicated and costly than that recited in claim 10. Furthermore, while Lim et al and Hsu et al teach plasma nitridation methods, neither reference teaches or suggests the steps recited in amended claim 10.

It is therefore Applicant's belief that even when taken in combination, the prior art references relied upon by the Examiner do not teach or suggest all the limitations of claim 10. For at least this reason, a *prima facie* case of obviousness cannot be established in connection with this claim. Furthermore, as it is Applicant's belief that a *prima facie* case of obviousness is not established for claim 10, the Examiner's arguments in regard to the dependent claims are considered moot and are not addressed here. Allowance of claims 10-15 is respectfully requested.

Conclusion

The Applicant believes that the application is now in condition for allowance and respectfully requests so.

Respectfully submitted,



Nelson A. Quintero
Reg. No. 52,143
Customer No. 34,283
Telephone: (310) 401-6180

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